**8. Super Tigre .61-H (with 1/4" crankshaft)**
**Pack #0546-22.**

- Install one #0325 flat washer (M16.0x10.0x1.0) onto the crankshaft. Disregard if your engine was previously equipped with a similar washer next to the bearing.
- Install the large I.D. (9.5mm) base collet #0546-6(with the tapered side upward away from the engine) into position against the factory 1.0mm thick front bearing spacer washer.
- Slide fan hub assembly #0579-4 onto the base collet.
- Insert the upper collet #0546-5 (8.0mm I.D.) with the tapered side facing down in the fan hub. **NOTE:** This collet has a 9.52mm I.D. step for crankshaft clearance.
- Follow with the #0331(M13.0x8.0x.5) flat washer. Apply a little Loctite to the factory nut and install and tighten firmly.

Following your appropriate collet pack and prior to inserting the urethane dampener, use the fan tool #0546-21 provided to hold the fan hub securely for crank nut tightening. Bolt the fan tool to the top side of the fan hub using two #0078 M4x12 socket head bolts, tighten the crankshaft nut securely. Remove the fan tool.

G. Select the (2 molded) dampeners #0546-16. Examine the drawing for the correct orientation of each dampener within the fan hub. In each case, the side with the small 1.0mm diameter "Dimple" (adjacent to the large through hole) is to be upward facing away from the engine. Apply talcum powder or a little soapy water (do no us oil, grease or silicone) to the dampener and push it fully into the slot provided until even with the top surface. Repeat with the second dampener. When completed, add a little talcum powder to the hole in each dampener to make clutch insertion easier.

Step 2. **Installation of Clutch Assembly and Align Engine.**

| Parts Required: | | Bag# |
|---|---|---|
| 1 #0285 | Aluminum Start Cone | 5C |
| 1 #0273 | Clutch Spacer Washer | 5C |
| 1 #106-87 | Pro-clutch Bell (Gold) inc. Gear, Liner and Bearings | 5C |
| 1 #0546-1 | Clutch Assembly | 5C |
| 2 #0053 | M3x5 Socket Head Set Screws | 5C |
| 1 #0558 | (Previously installed in frames from Section 2, step 7) | |

***Refer to Drawing #5.***

**IMPORTANT:** For this system to function properly it is essential that:

A. The clutch /bell assembly "hang" from the start shaft bearing block with a minimum of .10mm (.004) to a maximum of .2mm (.010") vertical end play prior to engine installation. This is accomplished by adjusting the height of the start cone or uni-lock adapter on the start shaft against the upper bearing. If additional height is desired for fuselage or similar application, a spacer must be added between the start adapter and the upper bearing.

B. Remove the previously installed double bearing block #0558 in the main frames.

C. Stack the spacer washer #0273, the clutch bell #106-87, and the double bearing block #0558 (circular side facing upward), onto the pre-assembled centrifugal clutch #0546-1. Slide the assembly up into position with in the main frames and install the aluminum start cone #0285 using two #0053 M3x5 socket set screws. Adjust the assembly until the proper end play is achieved. Secure the two #0053 set screws with Loctite. Once this is done, install the bearing block bolts #0077, washers #0003, and locknuts #0019 and make a preliminary gear mesh setting.

When aligning the pinion to the main gear #0557, two things must line up. First the two gears should have a little play between them throughout the entire rotation of the maingear and the pinion gear must be at 90 degrees to the main gear. The later can best be achieved by using a small bubble level that is easily obtainable at most hardware stores. Place the level on the outer ring of the maingear and level the mechanics, then place the bubble on the clutch bell. Once these two requirements are met, securely tighten the two M3x30 bolts.

NOTE: It is helpful to position the block as low as the bolt holes will allow, as in long term use, if any shifting occurs (from engine wear or loosening bolts) that there will still be some slight adjustment available to you without moving the motor mount.

Step 3. **Installing the Engine and Fan Shroud Braces.**

| Parts Required: | | Bag# |
|---|---|---|
| 4 #0080 | M4x14 Socket Head Bolts | 5D |
| 4 #0065 | M3x12 Socket Head Bolts | 5D |
| 1 #0549-6 | Fan Shroud Brace (Right) | 5D |
| 1 #0549-7 | Fan Shroud Brace (Left) | 5D |
| 1 #0546-19 | Alignment Tool | 5D |

***Refer to Drawing #5.***

A. Remove the previously installed motor mount #0191 from within the main frames. Only two of the #0063 bolts and all of the washer #0003 will be used.

B. The motor mount can be flipped over if necessary to vary its height in the mainframes. If you are using an O.S. engine the two holes next to each other will be on the top side of the motor mount.

C. Install the four M4x14 socket head bolts #0080. Tighten the bolts enough to hold the engine against the motor mount, yet still allowing you to slightly move the engine from side to side.

D. Slide the engine up into the frames and engage the Delrin ball and the drive pins on the bottom of the clutch into the Delrin isolators in the top of the flywheel. **Do not fully seat.**

E. Take the alignment tool #0546-19 and slide it between the top of the flywheel and the bottom of the clutch. Notice that it has a notch in the cutout area near the handle portion. This is for clearance for one of the drive pins.

F. Once the tool is in position temporarily secure the motor mount with one socket bolt M3x10 - #0063 and flat washer M3 #0003 in the further most rear hole of the motor mount on each side. Select both pieces of the fan shroud brace #0549-6 (right) and #0549-7 (left). The left hand version mounts via the uppermost and lowermost motor mount bolts through the 4.75mm and 3.0mm holes in the braces. When installed, the left hand version sweeps forward and inward at the top. The 4.75mm hole at the bottom allows fore and aft adjustment, while the slot at the top allows up/down fan shroud adjustment. The right hand version is the opposite. Use two M3x12 socket head bolts #0065 with the M3 large flat washers #0003 at the lower end of the brace (into the motor mount). It is best to use the rearmost motor mount bolt on each side to hold the motor and alignment while adjusting the fan shroud braces for proper fan clearance. Use Loctite on all motor mount bolts.

G. Push upward on the engine assembly while firmly holding the start shaft with downward pressure so that all components are snug against the alignment tool. Once in place, check to see that the start shaft still loaded downward ensuring that the clutch bell end-play is still evident.
Visually inspect the installation. (**Tip:** It is most helpful in alignment of this and other aspects of helicopter assembly to obtain very small bubble level to aid in alignment. If you cannot locate such items contact Miniature Aircraft USA for a source). The engine/clutch should be level and evenly contacting the alignment tool as viewed from all angles. Alternately tighten all motor mount/engine bolts and remove the alignment tool. Re-check for proper gear mesh and clutch bell end play.

H. Install the carburetor at this time.

Step 4. **Installing The Fan Shroud Assembly.**

| Parts Required: | | Bag# |
|---|---|---|
| 1 | #0548-5 Fan Shroud (left and right) | 5A |
| 5 | #0029 M2.2x13 Phillips Screws | 5E |
| 4 | #0061 M3x8 Socket Head Cap Screws | 5E |
| 2 | #0009 Flat Washers M3 small | 5E |

***Refer to Drawing #5.***

NOTE: Generally, the rear fan shroud mounting boss will tolerate any re-positioning of the fan shroud to accommodate the various gear ratios. If, for some reason, you would like to move the rear of the shroud also, there is extra plastic molded behind the bolt holes on each side to allow for the drilling of new holes. However, this is usually not necessary.

A. Install both halves of the fan shroud #0548-5 into position and then screw the halves together using five, M2.2x13 Phillips screws #0029 from the right side.

B. Place two M3 small washer #0009 on two M3x10 socket head bolt #0061 and thread them into the front fan shroud mounting holes through each upper hole in the fan shroud braces. Use a small amount of slow cyano on each bolt. Do not tighten completely.

C. Screw an M3x8 bolts #0061 into the fan shroud lower mounts on each side. Use slow cyano.

D. Align the final shroud so that it is square to the fan and then tighten all previously installed hardware. Check for no binding when engine is rotated. It may be necessary to loosen the four bolts #0065 holding the front fan shroud braces and re-adjust for proper fan clearance.

**NOTE:** It is possible to R & R the engine/motor mount assembly without disturbing the clutch/bell assembly or the gear mesh if your careful. You will find service, in this regard, to be far simpler than with the conventional system.

**"Fan Removal for R & R"**

Removal of the fan hub from the engine is quite simple. Support the fan/hub assembly from beneath as near to the engine as possible. Un-thread the crank nut until it is even with or slightly above the ends of the crankshaft. Tap the nut/crank with a wooden dowel and

hammer or the plastic handle of a tool. The upper collet should release easily, unless you have used excessive amounts of Loctite. If this is the case apply a little solvent such as acetone or thinner to the upper collet to help loosen the Loctite.

## VI. RADIO TRAY ASSEMBLE AND SERVO INSTALLATION

Step 1. **Installation of Radio Tray Frame Supports.**

| Parts Required: | | Bag# |
|---|---|---|
| 1 | #0535-1 Lower Radio Tray Support (Left) | 6A |
| 1 | #0535-2 Lower Radio Tray Support (Right) | 6A |
| 1 | #0347 Upper Tray Frame Support | 6B |
| 4 | #0063 M3x10 Socket Head Bolts | 6B |
| 4 | #0065 M3x12 Socket Head Bolts | 6B |
| 6 | #0019 3mm Locknuts | 6B |
| 2 | #106-60 Lower Canopy Stand-Offs | 6B |
| 6 | #0009 M3 Washers (Small) | 6B |

***Refer to Drawing # 7.***

A. Mount the upper tray frame support #0347 to the graphite vertical front plate #0586-23 using two M3x10 socket head cap screws #0063, two flat washers M3 small #0009, and two hex locknuts M3 #0019. Only assemble loosely at this time.

B. Mount the lower tray supports #0535-1 and #0535-2 to the lower frame rails 0586-21 and #0586-22 using four M3x12 bolts #0065, four 3mm small washers #0009 and four 3mm locknuts #0019. **Do not fully tighten.**

C. Mount the lower canopy stand-offs #106-60 to the lower radio tray supports with two M3x10 bolts #0063.

Step 2. **Mount Servo's into Plastic Tray Components and Assemble Plastic Tray.**

| Parts Required: | | Bag# |
|---|---|---|
| 1 | #0575-4 Upper Servo Tray | 6A |
| 1 | #0575-5 Lower Servo Tray | 6A |
| 1 | #0575-6 Main Vertical Support and Throttle Mount | 6A |
| 1 | #0575-7 Secondary Vertical Brace "H" | 6A |
| 1 | #0575-8 Switch Plate | 6A |
| 2 | #0029 M2.2x13 Phillips Tapping Screws | 6C |
| 15 | #0027 M2.2x9.5 Phillips Tapping Screws | 6C |
| 8 | #0001 Flat Washers 2mm (small) | 6C |
| 2 | #0575-3 Servo Spacer Blocks w/Three Holes | 6C |
| 2 | #0575-1 Servo Screw Doubler Blocks w/Two Holes | 6C |
| 4 | #0035 M2.2x16 Phillips Tapping Screws | 6C |
| 2 | #0351 Roll Servo Pivots (male) | 6C |
| 2 | #0353 Roll Servo Pivots (female) | 6C |
| 2 | #0508-1 Custom Tilt Bearings | 6C |

***Refer to Drawing # 7.***

A. **Servo Installation:** The order of assembly of the various plastic parts is not critical; however, experience has shown that it is more convenient to initially fit the servos prior to overall assembly. The reason for this is due to the adjustable nature of servo openings. Obviously this tray must accept all popular servo sizes, so the following will outline each servo installation.

**Mount Servo's as Follows:**

1. **Roll (Aileron) Servo:** Note that the aileron (roll) servo is mounted on pivots to allow it to rock fore and aft under control of the collective pitch servo ahead of it. Select the servo to be used for Roll control and install all four rubber grommets. Select a #0351 Roll Servo Pivot from the parts bag and, holding it in place under one end, use a small drill to mark it for proper hole drilling to accept two of the servo mounting screws from your radio hardware. (**NOTE:** Recognize that screwing this servo to the Pivot is just like screwing the servo down to a wood or plastic servo tray in that a small enough drill must be selected to allow your particular screws to thread into the plastic.) Drill the holes and screw the Pivot to the servo. In identical fashion, mount the remaining #0351 Pivot to the other end of the servo. Press two #0508-1 custom tilt bearings into the holes in the two #0353 Roll Servo Pivots. Hold the servo in approximate position centered in its clearance hole in the tray and press the bushings of the Pivot Supports into the servo Pivot ends (lightly grease).

Rotate each #0353 servo pivot into their respective position on the underside of the upper tray #0575-4. Hold the entire servo assembly and the upper tray together. Allow no side play in the servo and center the output spline with the true center of the tray(the rear hole of the screw to the vertical support #0575-6 is true center). Lightly cyano glue the pivot supports #0353. Re-check the servo alignment, good retention end-wise and freedom to pivot. Glue securely. From the top side of the upper tray drill two small holes through the slots provided into each of the servo pivots #0353. Secure using four #0027 (M2.2x9.5) self-tapping screws and four #0001 M2 washers.

2. **Collective Servo:** Select two plastic spacer blocks #0575-3. Using the original servo hardware, mount the blocks to the servo allowing at least 1.0mm of servo case clearance. Set the assembly into position in the tray. The output position of the servo is to the rear of the tray. Align the center hole on each block #0575-4 install a #0027 M2.2x9.5 Phillips Screw into each center hole. Center the servo within the opening and tighten all four servo screws previously installed. Apply a thin coat of cyano around each block #0575-3.

3. **Throttle Servo:** Select the vertical tray support #0575-6. Mount the throttle servo with the splined output shaft towards the rear. Secure servo using four #0035 (M2.2x16) Phillips tapping screws, four #0001 (M2) washers, and two #0575-1 doublers. Cyano doublers from the back side.

C. **Overall Assembly:** Refer to **View #7** for overall positioning of all plastic parts. It is best if a thin line of cyano is put on the mating surfaces prior to installation of the screws. Using two #0027 (M2.2x9.5) Phillips self-tapping screws, fasten the vertical tray #0575-6 to the underside of the upper tray #0575-4. Secure the secondary vertical brace #0575-7 ("H" shaped) to the front side of the vertical tray #0575-6 using one #0027 M2.2x9.5) screw. Mount the vertical brace with the screw eyelets pointing rearward (towards the helicopter's tail). Position the main lower plate #0575-5 and secure using two #0029 (M2.2x13) Phillips tapping screws through the front two holes in the upper servo plate #0575-4. Use four #0027 (M2.2x9.5) in the center two holes on the bottom side and the lower two holes holding the secondary vertical brace #0575-7.

Step 3. **Mounting Servo Tray to Mechanics.**

Parts Required: Bag#

Special Tool: One 3mm or 1/8" drill bit.

| | | | |
|---|---|---|---|
| 12 | #0003 | 3mm Large Washers | 6D |
| 6 | #0065 | M3x12 Socket Head Bolts | 6D |
| 6 | #0019 | 3mm Locknuts | 6D |
| 2 | #0009 | M3 Flat Washers (Small) | 6D |

***Refer to Drawing # 7.***

A. Mount the radio tray to the upper tray mount #0347 using two M3x12 bolts #0065, two 3mm small washers #0009 and two 3mm locknuts #0019. Before tightening the bolts that hold the tray to the bracket or the bolts that hold the bracket to the front frame plate #-586-23, make sure the tray is held up against the bracket tight and that the tray is level and not leaning left or right.

B. Using a 3mm or 1/8" drill bit and using the holes in the lower servo tray supports #0535-1 and #0535-2 as a guide through the servo tray and install the M3x12 bolt with the 3mm washers #0003 and 3mm locknuts #0019. Once these four bolts are in, tighten these along with the four bolts that hold the tray braces to the lower frames. Securely tighten all radio tray mounting bolts.

Step 4. **Mount Elevator Servo and the Gyro Motor Assembly.**

Parts Required: Bag #

| | | | |
|---|---|---|---|
| 4 | #0560-2 | Phillips Machine Screws (M2.5x14) | 6E |
| 8 | #0560-8 | Flat Washers M2.5 | 6E |
| 3 | #0389 | Electrical Wire Lead Retainers | 6E |
| 4 | #0020 | M2.5 Locknuts | 6E |

***Refer to Drawing # 7.***

A. Check servo clearance in the cutout #0586-5 graphite elevator plate and increase if necessary. Install all four rubber grommets and brass eyelets into the elevator servo provided in your radio system. Mount the servo with the out put position towards the rear in the following order using four M2.5x14 Phillips machine screws #0560-2, four M2.5 #0560-8 flat washers, the graphite elevator plate #0586-5, the main elevator servo unit, four more M2.5 flat washers #0560-8, and four M2.5 locknuts #0020. Snugly tighten.

B. Route the servo wire towards the front radio tray using the three electrical wire lead retainers #0389 provided. The retainers are used by pressing them onto the head on a 3mm bolt. A suggested wire route is to use the forward top bolt holding the tail boom support halves #0185, to the upper main shaft bearing block, to the back bolt holding the start shaft bearing block #0558 to the lower bolt holding the frame plate corner block #106-72.

C. Mount the gyro motor to the gyro plate #0586-25, using two strips of servo tape, on each side on the bottom of the gyro motor. **NOTE:** Most present day gyro unit will un-plug from the gyro amplifier and switch box. If yours does this, unplug now and re-assemble in section XI, step 1.

Step 5. **Assemble Collective Push-Pull Arm.**

| Parts Required: | | Bag# |
|---|---|---|
| 1 #0560-6 | Special Control Arm w/Bearings | 6F |
| 1 #0560-7 | Special Pivot Stud | 6F |
| 1 #106-25 | Stud Retainer Collar (gold) | 6F |
| 1 #0019 | Hex Locknut M3 | 6F |
| 1 #0051 | Socket Set Screw | 6F |
| 2 #0103 | Threaded Steel Balls | 6F |
| 2 #0015 | Hex Nuts M2 (2.5 long threads) | 6F |
| 1 #0107 | Threaded Steel Ball M3x16 | 6F |

***Refer to Drawing # 7.***

A. Insert one #0560-7 pivot stud down through the reinforcement hole provided on the upper servo tray between the collective and roll servo positions. Secure below with one M3 locknut #0019.

B. Study the drawings to determine which side the steel threaded balls are inserted on the special control arm #0560-6 on the collective push-pull unit. Bolt the two M2x5 threaded balls #0103 to the special control arm using Loctite and two 2mm hex nuts #0015. Apply Loctite to the M3x6 threaded ball #0107 and insert it into the special control arm and tighten.

C. Slide the special control arm #0560-6 onto the pivot stud #0560-7 followed by the retainer collar #106-25. Apply Loctite to the M3x3 set screw #0051. Thread it into the retainer collar and tighten.

## VII. INSTALLATION OF LANDING GEAR ASSEMBLY

Step 1. **Assemble Landing Gear and Install.**

| Parts Required: | | Bag# |
|---|---|---|
| 2 #0153 | Skids | 7A |
| 2 #0151 | Struts | 7A |
| 4 #0019 | M3 Locknuts | 7B |
| 4 #0073 | M3x20 Socket Head Bolts | 7B |
| 2 #106-66 | Main Frame Strut Plates (Graphite) | 7B |

***Refer to Drawing #6.***

Special Tool Required: Heat gun (Monokote type) or a source of heat such as boiling water.

A. Examine view on the drawing to determine orientation of the struts #0151 and skids #0153. Note that the struts sweep forward.

B. Wearing a glove or using a cloth for protection from heat, pick up one flexible strut and, with a skid conveniently at hand, heat one end of the strut until the skid can be pushed into the hole from the front without undue pressure. **Do not overheat!** Push the skid through until its end projects rearward through the strut exactly 227mm.

C. Pick up the second strut, heat it the same way and press it on the skid until the skid projects rearward from it exactly 62mm. Again check drawings for orientation. The distance between the bolt holes from the front to the rear strut should be 165mm.

D. Grasp the forward strut again, heat its opposite end and, in a similar fashion, press the second skid through this hole. Continue until it is about to engage the second strut. Now heat the rear strut and, before the front one cools, slide the skid through both into its final position.

E. Install the landing gear with two landing gear braces #106-66 between the landing gear and the lower aluminum frame #0163 and #0165. Use the four M3x20 bolts #0073 and M3 locknuts #0019.

## VIII. INSTALLING FUEL TANK SYSTEM

Step 1. **Assembling Fuel Tank System.**

Parts Required: Bag#

Special Tool: 3/16" Drill Bit

| | | |
|---|---|---|
| 1 #104-10 | Fuel Tank | 8A |
| 1 #0397 | Fuel Line (16 inches) | 8A |
| 2 #0682 | 8 inch Tie Wraps | 8A |
| 1 #0405 | Fuel Vent | 8B |
| 1 #0401 | Fuel Clunk | 8B |
| 1 #0403 | Fuel Pick-up | 8B |
| 2 #0011 | Fuel Fitting Washers M5x10 | 8B |
| 2 #0013 | Fuel Fitting Nuts 5mm | 8B |
| 1 #104-12 | Fuel Cap w/Plug | 8B |

***Refer to Drawing # 8.***

A. Study the drawings and drill the holes for the fuel tank fittings #0405 and #0403. Carefully clean all debris from the tank.

B. Mount the gas vent fitting #0405 using one M5x10 washer #0011 and one 5mm hex nut #0013.

C. Cut a piece of fuel line #0397 100mm long. Put the fuel clunk #0401 on one end the fuel fitting #0403 on the other. Install the assembly into the tank using one M5x10 washer #0011 and one 5mm hex nut #0013. Before completely tightening rotate the tank and check how the clunk works. It must fall down and touch each side as that side is facing downward. Rotating the clunk line will change this, either helping or hurting the clunking effect. Tighten the fittings, securely.
**NOTE:** The fuel Clunk must not touch the end of the tank when held on end, so as not to cause an obstruction in the fuel draw.

D. Before installing the fuel cap #104-12, rotate both plastic ends of each side of the rubber plug until none of the holes in the rubber are visible to ensure proper seal. Install rubber cap plug in the fuel tank #104-10 and tighten the center screw securely.

Step 2. **Mounting the Fuel Tank.**

A. Using two strips of servo tape on top of the fuel tank and position the tank under the servo tray and stick in place (Center the tank in between the lower canopy stand-Offs #106-60). Use the two 8 inch tie wraps #0682 to secure the tank.

## IX. ASSEMBLE THE TAILROTOR TRANSMISSION

Step 1. **Assemble Tailrotor Hub and Blade Holders.**

| Parts Required: | | Bag# |
|---|---|---|
| 2 | #3694 Graphite Tail Rotor Blades | 9A |
| 4 | #3694-1 Nylon Washers | 9B |
| 2 | #0019 Hex Locknuts 3mm | 9B |
| 2 | #0073 M3x20 Socket Head Bolts | 9B |
| 2 | #0103 M2x5 Threaded Steel Balls (Long Thread) | 9B |
| 2 | #0299 M4x10 Ball Bearings | 9B |
| 2 | #0439 M6x10 Ball Bearings | 9B |
| 2 | #0453 Tail Rotor Blade Mounts | 9B |
| 2 | #0457 T/R Thrust Bearings | 9B |
| 2 | #0446-2 Special Machined Nuts | 9B |
| 4 | #0446-3 Special Shims .001 | 9B |
| 4 | #0446-4 Special Shims .003 | 9B |
| 1 | #0541-7 One-Piece Machined 4mm Stud Steel Tail Rotor Hub | 9B |
| 2 | #3694-2 Knurled Spacers | 9B |

***Refer to Drawing # 9.***

**NOTE:** Remember to clean all steel components before applying Loctite.

A. Take the two tailrotor blade mounts #0453 and thread the M2x5 threaded balls #0103 into the outboard holes, using slow cyano.

B. Press the M4x10 ball bearing #0299 into the blade mounts, on the root end, seating them squarely and fully.

C. Pack the #0439 ball bearings full of grease and the wipe off any excess. Press the bearing onto the special nuts #0446-2 and seat them fully. **NOTE:** If more than thumb pressure is required, apply pressure to the inner race of the bearing only.

D. Lay out the two thrust bearing assembles #0457. Use two spare 4mm bolts for greasing and assembling the thrust bearings. Each bearing has one race that has a smaller I.D. Place the small I.D. halves on the two bolts with the ball grove facing up. Apply grease all the way around the groove. Next place the ball retainers with the cup sides up onto the balls. Apply grease to the top sides of the bearing race that has a larger I.D.. Place the other halves of the bearings on the bolts completing the assemblies, wipe off any excess grease.

E. Slide the blade holders onto the one piece machined steel T/R hub #0541-7 followed by the thrust bearings. **NOTE:** The large I.D. half of the thrust bearings has to go on the steel hub first, leaving the small I.D. half next to the shims #0446-3 or #0446-4 and the special nut #0446-2.

F. Thread the special nuts up onto the steel hub and lightly tighten. Check for end play in the blade holders. **NOTE:** If there is end play in the blade holders it will have **NO** adverse effect on the operation of the tailrotor due to centrifugal force loading the thrust bearing as it was designed to do. However two different sizes of shims are provided if you would like to remove some of the end play. **NOTE:** A small amount of end play must exist so as not to put the bearing in a bind. If shims are used, place an equal amount on each side because it is important to keep the distance equal between the center of the hub and each blade pivot hole. Remove the special nut #0446-2, apply Loctite and securely tighten.

G. Select the graphite tailrotor blades #3694, four plastic spacers #3694-1 and two knurled pivot bushings #3694-2. Press into each blade pivot hole one each #3694-2 pivot bushings. Insert one #0073 M3x20 socket head bolt (previously installed in step 1.) partially threw the blade pivot hole in the tail rotor blade mount #0453. From the inside of the blade mount slide one #3694-1 plastic bushing followed by a graphite tail blade and another #3694-1 plastic bushing. Press the socket head bolt entirely through the blade mount. Secure using one #0019 3mm locknut. Tighten only enough that the tail blade can rotate with slight pressure. **NOTE:** If the tail blade and mount are held horizontally the tail blade will not fall.

**NOTE:** Re-check drawing for correct tail blade directional orientation for a clockwise rotation. The tail rotor pivot bolts #0073 should be facing inward.

**Repeat entire procedure for the other tail blade.**

H. To balance the entire tail rotor assembly the #0429 tail rotor output shaft found in section 10D may be used as a balance bar. Slide the assembled tail rotor hub half way onto the shaft.
**NOTE:** To accurately balance the tail rotor, the tailrotor blades must extend straight out from the hub and parallel to each other.
Set this entire unit in between two "glass" glasses on a flat surface. If there is an imbalance the heavy blade will hang lower. Add weight in the form of a narrow strip of colored tape or preferable use a small 3mm washer on the blade pivot bolt of the lighter blade, to balance. (If the washer is used trim the washer with a pair of cutters to achieve the proper weight needed.) The tail should remain in any position if balance is correct. Proper blade balance is essential. Remove the output shaft #0429.

Step 2. **Assemble Pitch Slider and Bell Crank.**

Parts Required:

| | | | Bag# |
|---|---|---|---|
| 1 | #0018 | M2 Locknut | 9C |
| 2 | #0041 | M2x8 Slotted Cheese Head Machine Screws | 9C |
| 1 | #0043 | M2x10 Slotted Cheese Head Machine Screw | 9C |
| 1 | #0095 | Special Bolt Tail Rotor Bellcrank | 9C |
| 1 | #0101 | M2x5 Thread Steel Ball(Short Thread) | 9C |
| 2 | #0133 | Long Ball Links -- Long | 9C |
| 2 | #0159 | M3x7 Ball Bearings | 9C |
| 1 | #0361 | M2 Steel Ball | 9C |
| 1 | #0435 | Brass Tail Rotor Control Slider | 9C |
| 1 | #0437 | Plastic Control Slider Ring | 9C |
| 2 | #0439 | M6x10 Ball Bearings | 9C |
| 1 | #0441 | Plastic Pitch Plate - Tail Rotor | 9C |
| 1 | #0443 | Snap on Retainer Pitch Plate | 9C |

1 #0445 T/R Bellcrank 9C

***Refer to Drawing # 9.***

A. Begin by threading the M2x5 short threaded ball #0101 into the side hole of the control ring #0437. Use cyano and thread the ball squarely in place.

B. Place the two #0439 ball bearings (M6x10) on a clean paper with the balls visible. Lightly grease each.

C. Slide one bearing on the #0435 brass control slider. Lightly slide the control ring over the slider, followed by the other bearing, and finally the #0441 pitch plate small end first. Press together until the bearings squarely and completely enter the recesses in the control ring. Do not force.

D. Examine the #0443 pitch plate retainer, noting its four inside spring fingers and cupped shape. It will be pressed on the end of the brass slider to retain this subassembly, but this must be done with great care to ensure that the control ring is neither to tight nor to loose. The control ring bearings are precise and delicate but necessary for a tight play free tail rotor control.
Cut a hole just large enough to go over the end of the brass slider in a small piece of very thin plastic such as the flap from a plastic sandwich bag (Saran Wrap, etc) and place it over the slider against the pitch plate face. Rest the slider vertical against a wood or cardboard surface, pitch plate up, and press the retainer in place, cupped face **UP**. A piece of scrap wood with an appropriate drilled hole in it will be very helpful for this operation. Continue pressing the retainer in place until it seats against the thin plastic shim. Carefully tear and pull the plastic out. This should provide a subassembly in which the control ring is free to rotate smoothly but with negligible end play. Apply cyano to retainer clip where it touches the pitch control plate.

E. Screw #0133 ball links to the pitch plate using M2x8 machine screws #0041. Just seat the screws, so that the links can rotate with firm pressure.

F. Press the M3x7 ball bearings #0159 into the holes in the tail rotor bellcrank #0445, using the special bellcrank bolt #0095 to keep the bearings aligned during the process.

G. The control bellcrank #0445 has three 2mm holes in the control arm. In most cases the center hole provides the most efficient tail rotor control. From the top side of the tail rotor bellcrank #0445 thread in a control ball assembly as follows: one M2x10 slotted machine screw #0043, one M2 steel ball #0361, secure in place with one M2 locknut #0018. Use Loctite.

Step 3. **Assemble the Gearbox and Tail Rotor Hub.**

| Parts Required: | | Bag# |
|---|---|---|
| 1 | #0800-7 T/R Input Shaft 5.0 x 37.3mm | 9D |
| 4 | #0025 Phillips Pan Head Self Tapping Screws M2.2x6.5 | 9D |
| 4 | #0051 M3x3 Socket Set Screws | 9D |
| 1 | #0421-A T/R Gear Box Housing | 9D |
| 1 | #0421-B T/R Gear Box Housing | 9D |
| 4 | #0425 M5x13 Tail Gear Box Ball Bearings | 9D |
| 1 | #0429 T/R Output Shaft | 9D |
| 1 | #0431 E-Clip - Output Shaft | 9D |

| | | | |
|---|---|---|---|
| 1 | #0433 | Plastic Gear Spacer - Output Shaft | 9D |
| 2 | #0427 | Bevel Gears | 9D |
| 2 | #0056 | M3x5 Dog-Point Socket Set Screws | 9D |
| 4 | #0426 | .005" (.12mm) shims | 9D |

***Refer to Drawing # 9.***

**SPECIAL NOTE FOR INSTALLING #0427 OR #0547 TAIL ROTOR GEARS IN ALL X-CELL OR XL-PRO HELICOPTERS.**

Four #0426 - .005" (.12mm) shims are provided for adjusting the gear mesh. In most cases none will be required, however in some cases 1 or 2 per gear may be necessary to achieve optimal gear mesh.

The set-up procedure is as follows:

1.) Trial fit all components (without shims) and assemble gear box with a couple of the #0025 screws. To be accurate, it is necessary to insert the transmission into the tailboom each time you wish to check gear mesh. This is because the boom will slightly compress the transmission case.

Each shaft assembly should be individually test fitted with each transmission case in place to check for end-play and excessive bearing loads. The former is caused by the gear being set too far from the bearing or spacer and the later is from too much spacing causing the assembly to "snap" into place in the transmission.

2.) If it is determined that shims are required, trial fit one-at-a-time (never exceeding two in any one location) to optimize gear backlash. The above procedures must be adhered to each time a shim is tested (to avoid end play or bearing pre-load).

By examining the drawing you will see that only two positions are acceptable for shimming. Position (A) is behind the bearing nearest the gear on the input shaft and next to the stepped area of the transmission. Position (B) is outside the bearing on the output shaft but inside the flange of the transmission case.

The most desired gear mesh will be that of minimum backlash, even the point of having slight interference during rotation. This condition will " Break-in" during the first few flights. As with any similar system, we always recommend a through check over after the first 20 - 30 flights to ensure good mesh and change to new grease (to remove any break-in debris).

**NOTE:** At the builders discretion the bearings and shaft in this section may be glued together using loctite (red, green or blue). If you choose to do this the disassemble process will become very difficult and will require the application of heat to break down the glue.

A. At this time clean the input shaft #0800-7 and the output shaft #0429, the inner race on the four ball bearings #0425 and the two bevel gears.

B. At builders discretion apply a small amount of blue Loctite to input shaft #0800-7 next to the delrin coupler. Slide one of the bearings #0425 all the way up against the delrin. Lay the lower half of the T/R gear box #0421-A on the table and hold the input shaft over the T/R gear box half and apply a small amount of Loctite where the second bearing goes and slide the bearing into position. Apply blue Loctite to the two M3x3 set screws #0051 and start each in to the one bevel gear #0427. Place the gear on the shaft and run one of the set screws down and make sure that it is on the flat. Push this assembly down into the lower T/R gearbox half and adjust the gear so that no end play exist but without binding the two

bearings. Tighten the two set screws thoroughly and set aside this assembly to cure for a few minutes.

C. Snap the E-clip #0431 into the groove on the T/R output shaft #0429. Apply a small amount of Loctite to the small portion of the shaft beside the E-clip. Slide one of the two remaining bearings #0425 onto the shaft and up against the E-clip.

D. Apply blue Loctite to the two remaining M3x3 set screws and start them onto the other bevel gear #0427. Slide this gear onto the shaft teeth first and run one of the set screws down into the flat spot on the shaft. Slide the plastic spacer #0433 on next followed by the remaining ball bearing #0425. Apply Loctite where the bearing will sit. Lay the other T/R gear box half #0421-B on the table and place the output shaft into its perspective position. Once again adjust the gear and tighten so that there is no end play and no binding in the bearings. **Caution:** This is a small gear, do not over tighten.

E. Apply a liberal amount of grease to both gears. With the two shafts in there respective positions bring the two T/R gearbox halves together and install the four M2.2x6.5 phillips screws #0025. **NOTE:** Be sure to install the screws from the correct side. Check for binding, if any - recheck bearing and gear spacing.

F. Slide the T/R pitch slider onto the shaft. (Pre-Assembled in step 2)

G. Engage the control ring ball in the clip end of the bellcrank assembly #0445 from step 2 and squarely thread the special bolt #0095 into the gear housing #0421 from the bottom. Tighten the bolt until there is no play or bearing drag.

H. Check the orientation of the tail rotor hub assembly on the drawings. Slide the tail rotor hub #0541-7 onto the tail rotor output shaft #0429. Line up the threaded holes in the tail rotor hub with the cross hole in the output shaft, secure in place using two M3x5 dog point socket set screws #0056. Use Loctite.

I. Snap the two ball links #0133 onto the threaded balls #0103 on each tail rotor blade mount. Again check the drawing for proper orientation.

## X. BUILDING THE TAIL BOOM

Step 1. **Installing Tube Drive.**

| Parts Required: | | Bag# |
|---|---|---|
| 1 #0587-2 | Carbon Graphite Tailboom 6-Ply-Coated 31.5" | 10A |
| 1 #0809-1 | Tube Drive Shaft | 10A |
| 4 #0057 | M4x4 Set Screws | 10B |
| 2 #0800-2 | Delrin Shaft/Bearing Adapters | 10B |
| 2 #0800-3 | Torque Tube Ball Bearings | 10B |
| 2 #0800-4 | Delrin Bearing Supports | 10B |
| 4 #0800-5 | X-Cell O-Rings | 10B |
| 2 #0800-11 | Male Universals | 10B |

***Refer to Drawing # 10.***

A. Snap one inner bearing adapter #0800-2 inside the ball bearing #0800-3. Support the bearing below the inner race and press the delrin adapter in place until it snaps. Place the assembly over an upright outer delrin bearing support #0800-4 (cupped end) with the adapter flange upward. Press until it also snaps in place. Repeat with the other parts. Slide one O-ring #0800-5 into the first outside groove of either end of the completed bearing assembly. Pass a second O-ring in the same manner into the second groove. Repeat this process on the remaining bearing assembly. Using a wooden dowel or similar device which will slide inside the tailboom. Press each boom bearing assemblies into the tail boom 10.5" from each end. (**NOTE:** A small amount of dish washing soap and water inside the boom and on the rubber O-Rings will make the assembly slide easier.)

B. Note the design of the steel insert in the graphite shaft #0809-1. The alignment of the male universal #0800-11 is dictated primarily by its fit over the exposed portion of the steel insert. When slid in place, it will automatically stop at the end of the graphite tube. As a secondary point of alignment, the large I.D. bore of the male universal will snugly fit over the O.D. of the graphite shaft. This provides additional support for the ends of the graphite tube which are the most vulnerable to damage. There may be a little fitting necessary to install the male universal. Ideally, the fit should be a light press fit(never force it in any way). If the male part will not fit in this manner, simply lightly sand the last 15.0mm of the graphite tube with a little sandpaper such as 400-600 grit, using a rotating motion between fingers. When the male universal is properly positioned, you will see the center point of each milled flat directly in the center of the set screw holes. Apply Loctite and securely tighten the M4x4 set screws #0057.

**NOTE:** It is not recommended to apply adhesive to any part of the male universal installation since future service will be impossible.

After one male universal is in place, insert the graphite tube into the tail boom through each bearing assembly, sliding in far enough to allow installation of the remaining universal joint. Install the other universal #0800-11 in the same way.

Step 2. **Installing Tail Rotor Push Rod Guides and Fin Mounts.**

| Parts Required: | | | Bag# |
|---|---|---|---|
| 1 | #106-36 | Control Rod M2x29 | 10C |
| 8 | #0009 | M3 Small Washers | 10C |
| 2 | #0585-6 | Carbon Boom Supports | 10A |
| 1 | #0375 | T/R Push Rod (700mm) | 10A |
| 1 | #0588-8 | Horizontal Fin - Graphite | 10A |
| 1 | #0588-9 | Vertical Fin - Graphite | 10A |
| 4 | #0477 | T/R Control Rod Guides | 10C |
| 1 | #0385 | T/R Control Rod Coupler | 10C |
| 1 | #0479 | Horizontal Fin Mount | 10C |
| 1 | #0683 | Tailbox Clamp(with pre-drilled hole) | 10C |
| | | Assembled Tail Rotor Gear Box (From Section X) | |
| 4 | #0015 | M2 Hex Nuts | 10C |
| 4 | #0043 | M2x10 Slotted Machine Screws | 10C |
| 4 | #0019 | M3 Locknuts | 10C |
| 1 | #0025 | M2.2x6.5 Phillips Screws | 10C |
| 5 | #0032 | M2.9x9.5 Phillips Screws | 10C |
| 1 | #0063 | M3x10 Socket Head Bolt | 10C |
| 1 | #0073 | M3x20 Socket Head Bolt | 10C |
| 2 | #0133 | Plastic Ball Links(Long) | 10C |
| 2 | #0065 | M3x12 Socket Head Bolts | 10C |
| 4 | #0585-7 | Threaded Male Inserts | 10C |

| | | |
|---|---|---|
| 4 #0585-8 | Female Mounts | 10C |
| 2 #0027 | M2.2x9.5 Phillips Screws | 10C |

***Refer to Drawing # 10 and 11.***

**NOTE:** The notched end of the tail boom is the rear (Tail Transmission) side.

A. Slide the #0479 horizontal fin clamp onto the tailboom 9-3/8" from the rear. Loosely mount the four tailrotor control rod guides #0477 by wrapping them around the boom and securing each with an M2x10 machine screw #0043 and a M2 hex nut #0015. Mount one between the horizontal fin clamp #0479 and the "rear" end of the tailboom and mount the other three in front of the horizontal fin clamp.(The screws are long enough to allow the control rod to be snapped in from the sides when needed). Measuring from the notched end of the tailboom, the first control rod guide should be 122mm from the end. The next guide should be 165 millimeters from the first one. The next 2 guides should be 165 millimeters apart.

B. Slide the Tailbox clamp #0683 onto the boom and install the M3x10 bolt #0063 and M3 locknut #0019 which squeezes the clamp together. Do not fully tighten. **NOTE:** Notice that the boom is notched and that the tail box has a key on one side which when inserted into the boom notch will prevent any rotation of the tailbox.

C. Slide the assembled tailrotor gear box into the boom as far as it will go, slide the clamp up against the tailbox and align the three holes. Screw the tailbox to the clamp using the three M2.9x9.5 Phillips screws #0032 and slow cyano. Ensure that the tailbox is fully seated then tighten the M3x10 bolt in the clamp.

D. There is a small hole pre-drilled in the top of the clamp #0683. Using a #55 or a (.052) drill bit, drill through the boom and the top half of the tailbox. The bit will stop when it hits the input shaft. Install one of the three M2.2x6.5 Phillips screws #0025 into this hole. This screw will act as a safety to ensure that the tailbox cannot be ejected.

E. If you are electing not to paint the fins you may install the horizontal fin #0588-8 and the vertical fin #0588-9 at this time. Install the two remaining M2.2x9.5 Phillips screws #0027 in the two holes in the top of the horizontal fin #0588-8 and into the fin mount #0479. A small amount of Goop or silicone glue under the horizontal fin #0481 will help extend the life of the fin. Use two M2.9x9.5 Phillips screws #0032 to mount the vertical fin into the tail rotor transmission mount #0683.

F. Examine the central rod coupler #0385, noting that it will accept the control rods beyond their threaded portion. The intent is to better support the rods against bending. Use the coupler to join the tail rotor control rod #0375, and the tail rotor control rod extension #106-36. (Protect the rods with tape or cloth when clamping them to allow the coupler to be screwed on.) Be sure both rods enter the coupler approximately 7mm in depth. Start a long plastic ball link #0133 on each end of the push rod. Adjust to the lengths shown in drawing #11.

G. Slide the tailboom through the rudder support block #0818-2 and into the front tail boom support #0185. If the boom will not slide through the rudder support block with a slight twisting motion, then use a heat gun to expand the rudder support block #0818-2 prior to inserting the boom. Spin the main shaft back and forth until the tail drive engages, then push the boom in as far as it will go. Mark the boom next to the tailboom support halves #0185 with a piece of tape or put a small scratch on it with an X-acto knife. Slide the boom back about 2.0mm. Standing behind the model, sight the tailbox to the mainshaft. Make sure that the T/R shaft is perpendicular to main shaft. Tighten the four M3x35 bolts in the tailboom

support halves, then recheck alignment. **Option:** Due to the size of some workshops and the aggravation of spinning a model around on the table wondering what you are going to knock over next with the tailboom, you may want to wait until you've finished setting up the main mechanics before installing the tailboom.

H. Assemble each graphite boom support #0585-6 using four #0585-7 threaded male inserts and four #0585-8 female mounts as follows: Using 80 grit sand paper (or similar) roughen the smooth raised areas next to the threads on each #0585-7 threaded male insert. Clean both the #0585-7 and #0585-8 parts with alcohol or thinner.

Gluing the ends in place is a simple matter and can be done in a number of ways.

**METHOD** (A) - Apply J.B. Weld epoxy liberally to the threaded male insert #0585-7 (avoiding the threads) and the inside of each tube end. Push each insert in place until only the threads are exposed. Allow to dry overnight. The following day, apply RED Loctite, slow CA, or epoxy to the threads and screw each female mount #0585-8 in place. Note that each mount has a 2-1/4 degree angle milled into it to allow for the width variation from frames to tail clamp as shown in the drawing. Promptly proceed with steps "H" and "I". Obviously, the choice of adhesive will dictate the speed of which you must proceed in this step. Allow the assembly to cure fully before operation.

**METHOD** (B) -If you're in a rush, this is the quickest method. Screw each threaded male insert #0585-7 into a female mount #0585-8. Apply Slo C.A. to the insert and the I.D. of the female mount. Spray a little C.A. Kicker onto the graphite tube (on one end only) and insert it fully into the mount assembly. The other end must be assembled, aligned and installed without Kicker so sufficient time is available. (After installation Kicker can be used if desired). Again, be sure to study the drawing so that parts are not improperly aligned and not useable. **NOTE:** Before the glue has completely dried, recheck overall length of the tailboom supports, they should remain equal in length.

I. Mount each graphite boom support #0585-6 to the inside of the lower frames using two M3x12 bolts #0065, six 3mm small washers #0009 and two 3mm locknuts #0019.

J. Place a 3mm small washer #0009 on the M3x20 bolt #0073. Run the bolt through the left boom support then place a washer on the bolt. Next slide the horizontal fin clamp #0479 on the boom to line it up with the bolt. Use a M2.5 driver or allen wrench to thread the bolt through the fin mount. Place another washer on the bolt, slide the right boom support and secure with a 3mm locknut. **NOTE:** Before fully tightening make sure that the horizontal fin is square to the main shaft.

## XI. INSTALLATION OF REMAINING RADIO EQUIPMENT, ASSEMBLING AND INSTALLING PUSHRODS.

Step 1. **Install the Switch for the Receiver, Gyro, Radio Receiver, Battery and the Antenna.**

| Parts Required: | | Bag# |
|---|---|---|
| 5 #0389 | Electrical Wire Retainers | 11A |
| 2 #4695 | 4" Nylon Ties | 11A |

A. Provisions have been made in plastic tray switch plate #0575-8 for the receiver switch and the gain box for the gyro. If you elect to use these positions. Mount the two devices at this time.

B. Add an extension lead to the rudder servo and route the wiring forward along the right side of the helicopter. Use two electrical wire retainers #0389 to hold to the lower front Dog-Bone bolt and then to the upper fan shroud bracket bolt.

C. Plug all your servo leads into the receiver and gyro motor unit. Do not allow any wires to rub the corners of the graphite frames or any moving part. Three wire lead retainers are provided for holding gyro wires next to M3 bolt heads. Route all wires as neatly as possible using small tie wraps to hold in place.

D. Mount the gyro amplifier on the bottom side of the plastic servo tray just ahead of the fuel tank. Use double sided servo tape to secure in place.

E. Wrap the receiver and battery in foam and mount on the front of the plastic servo tray. the battery mounts best on the underside. Secure with either velcro or tie wraps loosely pulled.

F. If a whip antenna will be used, tests have proven that the best place to mount the antenna base is on the radio plastic tray #0575 sticking straight forward.

G. If you are electing to use a full length antenna, route it out of the canopy then down to the landing gear strut next to the skid and then back up to the tailboom. Again ensure that the wire doesn't rub any corners and is free from moving parts.

**SPECIAL NOTE:** If using a computer radio, clear all ATV's to 100%. Clear normal throttle and normal pitch curves so that they are symmetrical and throwing to there limits. Clear sub trims, trim memory, stunt trims, or anything that would change servo centering. Check direction of the servos
In the following steps, be sure to use Loctite on all steel threaded balls, nuts and screws.
All measurements given for pushrods are from the inside of the ball links at the connection point with the push-rods. Unless otherwise specified.

Step 2. **Install Rudder Servo and Pushrod.**

| Parts Required: | | Bag# |
|---|---|---|
| 2 #0389 | Electrical Wire Retainers | 11B |
| 4 #0020 | M2.5 Locknuts | 11B |
| 4 #0560-8 | M2.5 Flat Washers | 11B |
| 1 #0024 | M2.2x4.5 Phillips Self-Tapping Screws | 11B |
| 1 #0043 | M2x10 Slotted Machine Screw | 11B |
| 1 #0361 | M2 Steel Ball | 11B |
| 2 #0015 | M2 Hex Nuts | 11B |

***Refer to Drawing #11.***

A. As per the drawing mount the tail rotor servo to the rudder servo mount using four M2.5 flat washer #0560-8 and four M2.5 locknut #0020. Tighten securely, but do not over compress the servo grommets. NOTE: The servo output is towards the front of the helicopter.

B. OPTIONAL: A small M2.2x4.5 Phillips self tapping screw #0024 may be installed through the rudder servo block #0818-2 and into the boom. It will be necessary to drill a small hole prior to installing.

C. Route the tail rotor servo wires using two electrical wire retainers #0389. The front dog-bone bolt and the top bolt on the fan shroud front support #0549-6 works well for locating

the wire retainers.

D. Activate electronic tail rotor compensation (ATV) for "RIGHT" (Clockwise) rotor rotation. Check direction of tail rotor compensation and gyro. Put collective stick at the mid-position. Position a servo wheel on the tail rotor servo wheel on the tail rotor servo that it is square to the servo. As per the drawing, install one M2x10 slotted machine screw #0043, one M2 steel ball #0361 and one M2 Hex Nut #0015 into a hole at least 11mm out on the servo wheel and mount it at 90 degrees facing upward, Secure with Loctite using one M2 hex nut #0015.

**NOTE:** The Rudder ball on the servo wheel will be in a neutral position at 1/2 collective stick.

E. Bend the tail end of the tail rotor control rod approximately 168 degrees in order to align with the tail rotor bellcrank #0445. Snap the rear ball link #0133 onto the steel ball in the tail rotor bellcrank #0445. Adjust the position of the four rod guides along the boom to allow a free-sliding control rod and tighten their screws as well as the one in the front rod support. (Use Loctite.) Attach the front ball link to the rudder servo. Adjustment of the control rod will come later.

Step 3. **Install Elevator Pushrod.**

| Parts Required: | | Bag# |
|---|---|---|
| 2 #0313 | Special Control Rods | 11C |
| 2 #0135 | Ball Links (short) | 11C |
| 4 #0133 | Ball links (long) | 11C |
| 2 #0043 | M2x10 Slotted Machine Screws | 11C |
| 4 #0015 | Hex Nuts 2mm | 11C |
| 2 #0361 | M2 Steel Balls | 11C |
| 1 #0367 | Control Rod M2x60 | 11C |

***Refer to Drawing #11.***

A. Select the #0367 elevator control rod and two #0133 long ball links. The adjustment of this rod is critical and not open to any variations. Since the push-pull system works on a simple parallelogram system in conjunction with the elevator swing arm, the overall length of the #0367 rod is important. The gap between ball link base and ball link base (expose 2.0mm wire) is 34.0mm. Install this pushrod between the #0105 ball of the elevator bellcrank #0825 in the swing arm and the #0107 ball on the inside surface of the #0819-I special control arm.

B. Select a servo wheel or arm with a minimum radius of O.D. 24.5mm. Electronically neutralize your servo (being sure no "trim" exist on the transmitter). Study the drawing to show how to determine the correct positioning of the wheel. Each control ball will be mounted directly in-line with the center of the servo wheel approx. 19.5 - 20.0mm from center. Install each using one M2 steel ball #0361, one M2x10 slotted machine screw and two M2 nuts #0015 as a spacer and retainer. This is to say that the screws are installed from the outside with the nut next to each surface of the plastic wheel. If this is not adhered to, it is possible interference could result during operation.

C. Select two #0313 threaded rods. On one end of each install one #0135 short ball link fully. Follow this with one #0133 long ball link, leaving a gap between the links of about 4.0mm. Check each #0313 assembled pushrod for fit. Due to variations for each type of servo, you will need to adjust their length accordingly. You should attempt to keep each as equal in length as possible and adjusted so each can be freely "rocked" on its respective ball without

undue load at neutral. Only very minor deviations in one rod length to another is allowable. Keep in mind that maximum efficiency is obtained be equality and accuracy in such a set-up.

D. **Final Check:** With the elevator stick in neutral the elevator bellcrank control arm will be parallel with the main shaft.

Step 4. **Install Aileron and Collective Pushrods.**

| Parts Required: | | Bag# |
|---|---|---|
| 2 #0371 | Threaded Pushrods M2x90 | 11D |
| 4 #0133 | Ball Links (long) | 11D |
| 1 #0359 | Roll Servo Link Retainer Bar | 11D |
| 2 #0361 | M2 Steel Balls | 11D |
| 5 #0015 | Hex Nuts 2mm | 11D |
| 1 #0101 | Threaded Steel Ball M2x5 | 11D |
| 1 #0313 | Threaded Pushrod M2x10 | 11D |
| 2 #0135 | Ball Links (short) | 11D |
| 2 #0045 | M2x14 Threaded Machine Screws | 11D |

***Refer to Drawing #11.***

A. Study the drawing showing the special control arm assembly on the aileron pivoting servo. **NOTE:** that the three control rods running to it have their ball links trapped by the arm assembly and therefore, must be fabricated first.

B. Select the M2x10 threaded pushrod #0313 and install two plastic ball links short #0135. Thread them on until the two links base is about 2mm apart.

C. Select the two thread pushrods M2x90 (curved) #0371 and thread one #0133 ball link(long) onto each end of both control rods. Thread the links on the curved ends of the rods until the base of the ball link #0133 is 11mm from the center of the bend in the rod #0371. Thread the remaining ball link on until a distance of 72mm is achieved between the base of the links.

D. Snap one M2 steel ball #0361 (drilled version) in the ball links on the bent ends of the two aileron rods #0371.

E. Insert one M2x5 threaded ball #0101 in the center hole of the roll servo link retainer bar #0359 from the bottom and secure it with one hex nut M2 #0015. Use Loctite.

F. Select a double ended servo arm from the radio system hardware, long enough to match the 24mm hole separation on the retainer bar. If necessary, obtain an un-drilled arm or wheel and drill and shape it to suit. Center the servo electronically and mount it exactly parallel with the servo lengthwise.

Insert an M2x14 screw in each end hole of the retainer bar, slide an aileron roll bar on each and secure with an M2 hex nut. Snap the collective rod ball link on the center ball and mount the assembly of the three rod to the servo arm. Secure with two M2 hex nuts from underneath the arm. Tighten securely using a small wrench or long-nosed pliers. Use Loctite. Check the configuration against the drawing. (Collective rod forward). Snap the remaining ball link end on the underside of the collective push-pull arm #0560-6.

Step 5. **Install Collective Push-Pull Pushrods.**

| Parts Required: | | Bag# |
|---|---|---|
| 2 #0313 | Threaded Rods M2x10 | 11E |
| 2 #0135 | Ball Links (short) | 11E |
| 2 #0133 | Ball Links (long) | 11E |
| 2 #0043 | M2x10 Slotted Machine Screws | 11E |
| 4 #0015 | Hex Nuts 2mm | 11E |
| 2 #0361 | M2 Steel Balls | 11E |

***Refer to Drawing #11.***

A. As per the drawing position the push-pull arm #0560-6 to the following specifications.

   1) A line drawn from the pivot stud #0560-7 through the threaded ball #0107 mount on the underside of the control arm #0560-6 is exactly parallel with the lengthwise centerline of the roll servo and the roll servo cutout.

   2) A line drawn through each #0361 ball atop the bellcrank is exactly perpendicular to a line drawn from the pivot stud center to the servo spline center.

B. Adjust the short collective push-pull rod assembled in step 4 (with the aileron rods) until the aileron servo is exactly vertical with the push-pull arm positioned as described.

C. Electronically neutral the collective servo with the collective stick on the transmitter at mid (one-half) position. The servo wheel is installed so that a line 2.5mm behind the servo spline center drawn through two 2.0mm holes(drilled on a 20.0mm diameter circle) is exactly parallel with a line drawn through the #0361 balls atop the control arm, at hover point. Study the drawing to further clarify this relationship.

D. This is important to understand and execute accurately to avoid servo binding at full A.T.V. Once you've drilled the correct holes(a #53 - .059" drill or 2.0mm works best). Install two #0361 steel balls using two #0043 screws with M2 nuts as spacers and retainers. This is to say that the screws are installed from the outside with a nut next to each surface of the plastic wheel. if this is not adhered to, it is possible interference could result during operation.

E. Select two #0313 M2x10 threaded rods. On one of each install one #0135 ball link short fully. Follow this with one #0133 ball link long, leaving a gap between the links of about 2.0mm. Snap the assembled links in place.

F. With the collective stick at open one-half position, the aileron servo should be exactly vertical and both aileron bellcranks are vertical (or level). Adjust the aileron rods #0371 until the bellcranks #0167 are positioned correctly. Keep both aileron rods the same length.

Step 6. **Install Lower Swashplate Controls Rods.**

| Parts Required: | | Bag |
|---|---|---|
| 3 #0227 | Threaded Rods M2x18 | 11F |
| 6 #0133 | Ball Links (long) | 11F |

***Refer to Drawing #11.***

A. Start a long link on each end of the three swashplate control rods #0227 and adjust to a length of 31mm. Snap the three rods onto the lower swashplate ring, front side of the elevator bellcrank #0825, and to the #0167 aileron bellcranks.

Step 7. **Install Throttle Pushrod.**

| Parts Required: | | Bag |
|---|---|---|
| 1 #0373 | Threaded Rods M2x130 | 11G |
| 2 #0133 | Ball Links (long) | 11G |
| 2 #0361 | M2 Steel Balls | 11G |
| 4 #0015 | Hex Nuts 2mm | 11G |
| 2 #0043 | M2x10 Slotted Machine Screws | 11G |

***Refer to Drawing #11.***

A. Install one M2x10 slotted machine screw #0043, one M2 steel ball #0361, and one hex nut M2, into the carburetor arm (outer hole). Secure on the back side with a hex nut 2mm #0015. Use Loctite. Adjust the carburetor arm so that it throws in a symmetrical arc on the upper side of the carburetor.

B. Start a long ball link #0133 on each end of the throttle pushrod #0373.

C. With the collective stick in the middle position, mount a servo wheel on the throttle servo pointing straight down. Position the carburetor at 50 percent or half-throttle. Adjust the throttle pushrod so that it is the same length as the distance between the carburetor arm and the center of the servo arm. Snap the pushrod on the carburetor. Move the collective throttle stick from high to low with the throttle trim full down moving the throttle rod with it to determine where the control ball should be positioned on the servo wheel.

D. As described in step "A" install another steel ball assembly into the throttle servo wheel. Snap on the pushrod then adjust the A.T.V.'s at full and low stick to fine tune the throw.

Step 8. **Install Rotor head, Flybar and Hiller Control Rods.**

| Parts Required: | | Bag |
|---|---|---|
| 1 #0840-6 | 3.0mm Hardened Precision Dowel Pin | 11H |
| 8 #0133 | Ball Links (long) | 11H |
| 4 #0135 | Ball Links (short) | 11H |
| 2 #0313 | Threaded Rods M2x10 | 11H |
| 2 #0335 | Threaded Rods M2x75 | 11H |
| 2 #0337 | Threaded Rods M2x27 | 11H |
| 1 #0057 | M4x4 Socket Set Screw | 11H |

***Refer to Drawing #11.***

A. Slide the rotor head down onto the main shaft and align the hole on the top side of the main shaft #0614 with the hole in the C.N.C. head block #0844-1. This can be accomplished by holding the rotorhead in one hand and spinning the maingear clockwise with the other. Install one 3.0mm hardened dowel pin #0840-6. (chamfered end is used for entry) into the rotor head/main shaft. If the dowel pin will not fully insert through the main shaft with only moderate pressure, rotate the head 180 degrees upon the mainshaft and repeat. (The small access hole on the opposite side of head will allow a 2.0mm wire or 1.5mm Allen driver to

be used to push the dowel out.) Once the dowel pin has fit properly secure in place using one m4x4 socket set screw, using Loctite. Next tighten the previously installed M3x14 socket head bolts #0067 on the lower opposite side of the rotor head. Again use Loctite.

B. At this point check to see how free the washout block slides up and down the guide pins #0840-27 in the bottom of the head block. If it is stiff, disengage the wash out block and rotate it 180 degrees and try again. Determine which way is best and use pliers to tweak the pins a small amount as needed to one side or the other until the washout block slides up and down the pins with a minimum of drag.

C. Start a long ball link on each of the two flybar control rods #0337 and adjust to 9mm. Snap both control rods to the flybar control arms and washout arms.

D. Start a long on each end of the Hiller control rods #0335 and adjust to a length of 58mm. These rods go from the bell mixers on the blade holders to the swashplate. Snap both into position.

E. Start a short ball link #0135 on each end of rod #0313 and adjust to a length of 1mm between the ball links. These rods go from the bell mixer to the delta plate on the rotor head.

## XII. CANOPY PREPARATION

Step 1. **Mounting the Clear Lexan Window.**

Part Required:

| | | | |
|---|---|---|---|
| 1 | #106-96 | Lexan Window | Box |
| 1 | #0504-1 | Epoxy Glass Canopy | Box |
| 12 | #0024 | M2.2x4 Phillips Pan Head Self Tapping Screws | Bag 12 |
| 1 | #103-99 | Decal Stripping Sheet | Box |

***Refer to Drawing #12.***

**NOTE:** Because of current trends to apply wild paint job to canopy and fins, the window area was left in the canopy to allow people to express their creative side. However, a clear Lexan window is supplied for those who wish to be able to see in.

A. If you wish to use the Lexan window you must cut the opening in the canopy. Cut just inside the scribe line with a cutting wheel and clean up with a sanding drum, small file or sand paper.

B. Examine the Lexan window and note that there are two scribe lines around it's perimeter. The outer most line is your guide for cutting. Cut about 2mm - outside this line using sharp scissors or a dremel tool and cutting disc (USE EYE PROTECTION).

C. If you wish to screw the window in place, twelve self tapping screws #0024 (M2.2x4.5) are provided. The location of each screw is shown in **drawing #12.** After determining location of each of the 2.2x4.5 Phillips self tapping screws #0024, drill a hole at each location using a #56 or .046 bit. Holes should be 3mm from edge of canopy opening.

**NOTE:** Alternately, Miniature Aircraft USA canopy glue #0502 or epoxy can be substituted for screws. Use coarse sand paper (80 grit) to roughen the surfaces to be glued.

Position window in canopy and starting at the nose, drill a hole using the same bit. Start

screw and tighten snug. Next, drill the center hole on top. Work your way along each side installing screws as you go.

**NOTE:** Once the canopy is painted and window is permanently installed, apply a drop of Polyzap or Goop to the screws on the inside of the canopy.

D. Cut out and apply the decal striping kit as desired.

Step 2. **Mounting Canopy.**

| Parts Required: | | | Bag# |
|---|---|---|---|
| 2 | #0003 | 3mm Large Washers | 12 |
| 2 | #0063 | M3x10 Cap Head Bolts | 12 |
| 3 | #106-97 | Rubber Grommets | 12 |

***Refer to Drawing # 12.***

A. Drill a 1/8" guide or starter hole in the marked location for the canopy mounts and grommets. Use a grinding stone or a tapered reamer to enlarge the holes to 7.5 - 8mm. It may be necessary to use a small screwdriver to help work the grommets into the canopy. Apply medium cyano to each grommet **inside** the canopy.

B. To install the canopy on the model, slide the canopy into position apply thumb pressure to the grommet on top of the canopy on the standoff, push grommet down until it seats. Hold the canopy on both sides and pull it over the lower standoffs and push grommets all the way on. Place a 3mm large washer on both M3x10 cap head bolts and screw into standoffs. **NOTE:** Refer to (section X) to determine whether or not cutouts are going to be made in the canopy for switch and gyro gain access.

Step 3. **Installation of Thumb Screw Plastic Caps.**

| Parts Required: | | Bag# |
|---|---|---|
| 2 | #106-95 Thumb Screw Plastic Caps | 12 |

***Refer to Drawing # 12.***

**NOTE: Installation of Thumb Screw Plastic Cap for Canopy Retainer Screws:** Suggestion - Use #106-60 or #106-62 stand-off and a block of wood. Thread the M3x10 bolt fully into the #106-60(or 62) stand-off and place the plastic cap upside down on a flat surface. Use a block of wood and hammer (or bench vise) to press the bolt head into the plastic cap. **NOTE:** It is a hard press, no glue is needed.

## XIII. BUILDING THE ROTOR BLADES

**ATTENTION!**

**Read instructions before building these blades. Blade reinforcements MUST be glued with a generous amount of SLOW CYANO ONLY. They must also be clamped tight with vise grips or vise, overnight. No other glue will work satisfactorily.**

**IMPORTANT:**

**Use ONLY fresh "Slo Zap" or other standard thick C.A.. Do not apply any "kicker" or accelerator to either surface (wood or plastic).**

**Do not use other "Zap" C.A. products such as "Blade Zap", "Flex Zap", "Plastic Zap" or other brands of specialized cyano products, or any epoxy products to glue the reinforcements in place. Always roughen the plastic inner surface with coarse (40 - 80 grit) sandpaper or the backside of an X-Acto knife prior to gluing. Apply only to sanded wood (no paint, sealer, or other wood surface finish).**

Step 1. **Assembling Blade Reinforcements.**

| Parts Required: | | | Bag# |
|---|---|---|---|
| 2 | 3651-1 | Wood Rotor Blades | Wrapped in Box |
| 4 | 0019 | M3 Locknuts | 13A |
| 4 | 0071 | M3x18 Socket Head Bolts | 13A |
| 2 | 3651-5 | Pro .60 Blade Reinforcements(Tops) | 13A |
| 2 | 3651-5 | Pro .60 Blade Reinforcements(Bottoms) | 13A |
| 4 | 3674-6 | Carbon Fiber Inserts | 13A |
| 2 | 3723 | Brass Blade Pivots | 13A |

***Refer to Drawing # 13.***

A. First identify the top and bottom plastic blade reinforcements #3651-5 marked with a "T" and "B". Thoroughly rough up the surface to be glued using either 36 - 40 grit sand paper or a sharp object.

B. Match the holes in the carbon fiber plates #3674-6 with the blade reinforcements #3651-5. Thoroughly rough up the mating surfaces on each.

C. Press into the larger of the three holes in each blade root-one #3723 brass blade pivot. Center the brass pivot in the holes.

D. Press each top and bottom plastic reinforcement onto the brass pivots on each blade. Line up the two bolt holes in each reinforcement with the two small holes in each blade. Press one #0071 socket head bolt threw any of the two holes in each blade. With a pencil or pin trace around the outer perimeters of each plastic reinforcement #3651-5 (Both top and bottom). Remove the bolts #0071 and plastic reinforcements #3651-5.

## WARNING: Blade reinforcements must be glued using SLOW CYANO ONLY. No other glue will work satisfactorily. Read Section "E" entirely before proceeding.

E. Match each blade reinforcement #3651-5 with it corresponding carbon fiber insert #3674-6. (Refer to section "B"). Insert into the two small holes on each carbon fiber insert two #0071 socket head bolts. (**NOTE:** The surface which was not sanded will be on the bolt head side). On the top side of the rotor blade liberally apply slow cyano glue to the inside of the traced area for the blade mount. Press the top plastic reinforcement onto the glued area while lining-up the two bolt holes. Wipe away any excess glue. Immediately apply slow cyano to the insert area for the graphite plate. Press the matching graphite plate into position. Again wiping away any excess glue. Completely thread both of the socket head bolts into the blade.

On the bottom side of the blade repeat the above process using the bottom plastic blade reinforcement with matching carbon fiber insert. Secure by using two #0019 M3 locknuts and by clamping the blade pivot area with vise grips, table vise or a suitable clamping device. Allow to thoroughly dry.
Repeat step "E" on matching blade.

Step 2. **Adding Lead Strips.**

| Parts Required: | | Bag# |
|---|---|---|
| 2 | 3674-8 3/16" x 362mm Round Lead | 13B |
| 3 | 3712 Balsa Blade Caps | 13B |

***Refer to Drawing # 13.***

A. Sand each rotor blade with 220 or 320 grit sandpaper until very smooth. (Use of a sanding block and proper attention to thin trailing edges will ensure retention of the correct airfoil. Be certain the trailing edge remains straight during this operation.

B. Cut the lead strips #3674-8 into four lengths, the same length as the long slots along the leading edge of the blades. Cut two shorter pieces of lead for the two shorter slots. Be sure that all like lead strips remain equal in length.
**NOTE:** Using a sanding block, sand each lead strip on a flat surface by rolling under sanding block. If an exact gram weight is desired, the use of a gram scale will be necessary.

C. Place all the lead strips in their respective slots and weigh the blades on a gram scale or our new blade balancing system #0514. The total weight should be the same. If not, trim the lead in one of the slots until equal weight is achieved.

**NOTE:** If a gram scale is not available the following guide may be used:

| | |
|---|---|
| Net blade weight (weight is written or root of blade) | +____ grams |
| Approximate weight of lead and wood strips installed | +_44__ grams |
| Approx. Blade covering installed | +_12__ grams |
| Approximate weight of blade mounts installed | +_15__ grams |
| Total Flying Weight | =_____ grams |

D. If less weight is desired, trim one of the lead pieces in each blade until desired weight is achieved.

E. If more weight is desired, you may also add bronze powder #3709 to the blades.

F. Starting at the outer end of the slot, apply a coat of thin cyano around the lead in the slots. Allow to sit for about 30 seconds, then apply cyano accelerator. Repeat this process until near the top. A small gap must be left as to allow room for the balsa strip #3712.

Step 3. **Initial Balance.**

***Refer to Drawing # 13.***

A. As an initial step in balancing, we will now establish the center of balance point. Using a BIC type pen, dowel, or tube of any type, position the blade lengthwise in front of you on a level surface. Using the pen as a fulcrum at 45 degrees to the leading edge, determine the

balancing point, mark the blade accordingly, and repeat at 90 degrees to the previous line. (Hint: Gently rotate the pen right or left until the balance is established, and mark well for future reference, even after sanding). Both blades should balance within 1-2 millimeters of each other. Since they were factory matched and all material added accurately measured, you should have no difficulty. However, if there is an imbalance, the blades may be matched by two possible methods. First, determine which blade you wish to shift and in which direction. For example, if tip weight is to be added, simply rout out a small area at the tip of the blade slot and glue in a small amount of the excess lead strip as needed. Keep in mind that any weight added to the blade being corrected, must also be added to the other blade at the **center of balance point**, thus retaining the original balance of the two blades. The optional bronze #3709 powder may also be used as a balancing aide.

B. Cut balsa strips #3712 for each slot and trim to fit (i.e. round corners). Press balsa firmly into slots and secure with cyano on all sides. Block sand the raised portion until flush with the blade surface. Coat with a film of cyano and wipe away excess.

C. At your option, seal the wood at the hub and tip areas with either instant cyano or fuel-proof paint. Lightly re-sand blades with 220 or 320 grit sandpaper once again. Carefully remove all dust using a clean towel or a tack rag, wiping several times. At clean blade is a must for proper adhesion of the blade covering material.

Step 4. **Cover Blades**.

Parts Required:

2 3674-7 Blade Covering White (In box)

***Refer to Drawing # 13.***

A. With the blades now ready for cover, select a clean flat surface and after removing the backing material from a piece of blade covering #3674-7, lay it adhesive side up. Now carefully measure 10mm in from the near edge and mark each end with a ballpoint pen. Holding the blade with the hub in your left hand and the blade tip in your right hand, set the trailing edge down on the mark from the left end of the covering in a position to just clear the base of the hub when it is wrapped into position. Rock gently to adhere the covering to the trailing edge.

At this point, the 10mm section of blade covering will be visible between yourself and the blade trailing edge. Fold the blade toward yourself and apply pressure on the 10mm section of the marked covering. This will establish the bottom of the blades. Lift the blade up with covering clinging to the trailing edge and firmly smooth the short 10mm side onto the underside of the blade with a continuous slide of the finger. Continue rubbing the entire trailing edge as you rotate the blade upright. Do not allow the covering to touch the top blade surface until the trailing edge is firmly bonded with a clean, sharp fold.

Now rotate the blade further and progressively smooth the covering end to end as you go. Continue around the leading edge and back to overlap the starting edge of the covering on the bottom of the blade. Trim excess covering neatly from the blade and smooth the entire surface again. Repeat this process with the other blade. **Note:** A useful technique to allow good control of this sticky material and to prevent it from prematurely adhering to the blades in any area, weight the covering by sticking a piece of wire on what will be the final edge of the covering to be adhered, before starting. This will cause the covering to maintain a continuous roll-away from the blade surface until deliberately pressed down. Repeat entire process with the remaining blade.

Step 5. **Final Balance of Blades and Rotor Head.**

***Refer to Drawing # 13.***

A. Equipment Required: **NOTE:** The performance potential of modern R/C helicopters is so great that the use of specialized equipment for proper assembly and set-up is fully justified by the results achieved. This is particularly true of balancing procedures for all rotating parts. Nothing so clearly distinguishes one helicopter from the rest as perfect blade tracking and freedom from vibration. This manual describes only the procedure usable without special equipment which includes balancing the fly bar on its own bearing in the pivot block, and then suspending the head with main blades from the flybar across two straight edges, such as two rectangular blocks of wood. This procedure has been proven very effective and produces a vibration free head. The ultimate in head balance can be achieved by using a good static balancer such as the balancer #0514 sold by Miniature Aircraft USA or its equivalent. Its value lies in its ability to include main blade balance. If you have such a unit, use it following the instructions with it.

B. As described in Section 1, Step 6-G. Recheck balance of rotor head paddles.

C. Remove the rotor head from the main shaft. Mount the main rotor blades to the head using M4X35 socket head bolt #0082 and M4 lock nuts #0021, temporarily installed in section I. Position the blades straight out from the head and tighten the screws just enough to hold the blades in position.

D. Obtain two wood blocks at least 75mm (3 inches) high with parallel surfaces (2 short sections of good quality 2x4 serve very well) and two single side razor blades. Then, suspend the head and blade assembly between them supported on the fly bar. One main blade will invariably tilt downward.

**Note:** As described, before rotation of main blade on rotor head may result in a better balance. Cut a partial strip of the red tape provided (the degree of unbalance will give an indication of the width necessary) and apply near the end of the light opposite blade. Just stick a corner of the tape to the blade until the exact amount is determined. When exact balance is achieved (when the blade tips are equal distance from the bench top) apply the tape to the blade starting underneath, as with the regular covering.

E. Re-install the entire balanced rotor head assembly onto the main rotor shaft.

## XIV. FINAL MECHANICAL AND ELECTRONIC SET-UP

Step 1. **Setting up the Collective Servo.**

***Refer to Drawings # 14.***

A. Move the collective stick slowly all the way to the top and check that the collective arm is going as far as possible without putting the elevator bellcrank #0825 in a bind where it sticks through the mainframe and adjust ATV as necessary.

B. Move the collective stick slowly all the way to the bottom and adjust the ATV so that the collective arm goes all the way to the bottom without binding.

C. With the pushrod lengths given you should be able to use 100 to 110% ATV travel on the pitch servo.

D. With the collective stick at the top check that the swashplate is moving all the way to the top without binding. Adjust the four lower swashplate rods #0227 if necessary.

E. Once again check all collective and aileron, servo's, bellcranks, and pushrods at one half throttle stick for vertical and horizontal positioning.

Step 2. **Final Swashplate and Fly-Bar Alignment.**

***Refer to Drawing # 14.***

**NOTE:** Miniature Aircraft offers both swashplate and fly-bar alignment tool kits. Order #0510 and #0512.

A. **Swashplate:** A final check for a level swashplate may be achieved with the use of a main rotor pitch gauge (#0526) and a fly-bar lock (#0505). All transmitter stick and servo arms should be in a neutral position. Snap the fly-bar lock into the rotor head. Position the pitch gauge on one main rotor blade and set the pitch reading in the blade. Rotate the main rotor head in all four 90 degree positions. If the swashplate is truly level,the pitch reading will remain the same in all four positions. If incorrect, adjust the rods just below the swashplate until a level swashplate is achieved.

B. **Fly-Bar Paddles:** Now that the swashplate has been leveled, the fly-bar paddles may also be leveled, set your pitch gauge on 0 degrees. position on the paddle and adjust the paddles until they are level(Parallel) with the main rotor head. A straight rod such as a fly-bar may be used on the rotor head top as an aid in aligning the paddles. It is very important that the fly-bar control arms #0848-8 and the fly-bar paddles are all in-line to each other as per the drawing. For an excellent aid order #0510. (Fly-Bar alignment tool kit).

Step 3. **Adjusting Pitch Curves.**

***Refer to Drawing # 14.***

A. If you have selected an FAI type set up, you will probably want to run, depending on blade selection, 5 to 6 degrees of pitch in a hover (one half collective stick position) with about 10 degrees of pitch at full stick position and about 3 degrees of negative at low stick position. For the idle-up(s) you will want around 4.5 to 5 degrees of pitch at hover, 8.5 to 9.5 degrees at full top and 2.5 to 4 degrees of negative at low. For throttle hold, you will need about 5 degrees at hover, 11 or 12 degrees of positive at full and 4 to 5 degrees of negative at the low.

If you are setting up for hot-dogging, normal stick for hovering should be roughly the same as an FAI set-up. The same is true for the first idle up if your radio is equipped with two idle ups. You would use the first idle up for doing normal aerobatics, then the second idle up would be set up with 0 degrees of pitch at half stick, 4 degrees of negative at quarter stick, 4 degrees of positive pitch at three quarter stick and between 8.5 to 9.5 degrees of positive pitch at full and between 8.5 to 9.5 degrees of negative pitch at low. Throttle hold should be similar to the FAI set up, with the exception of maybe having a little more negative pitch at low for quick descents.

Step 4. **Adjusting Swashplate Throw.**

***Refer to Drawing # 14.***

A. Set the pitch gauge for 0 degrees of pitch. Move the collective stick until pitch gauge lines up with flybar. Set the pitch gauge for -6 degrees and with the main blades running parallel to the tail boom, give full right cyclic and adjust ATV so that the rotor blade has -6 degrees of cyclic pitch change. Repeat this process for the other side using +6 degrees on the pitch gauge. Repeat process for the elevator set up. This is the recommended maximum amount of

swashplate travel that should be used.

Step 5. **Adjusting Rudder.**

***Refer to Drawing # 14.***

First check servo for proper directional travel. Right tail stick command pulls the pushrod forward. Reverse if necessary. Turn on the ATS mixing function (for right hand rotation) on your transmitter. The 0 point should be at 1/2 throttle stick position. Adjust the low and high point to approximately 25% each. This will provide a good starting point for your first flight. Check for proper compensation direction by increasing the throttle stick. This should result in pulling forward like a right hand command. Re-Check that at 1/2 throttle stick the rudder servo arm has remained in neutral.
With the throttle and rudder stick in their center position adjust the tail rotor control rod until the outer hole in the tail rotor bellcrank #0445 is approximately 1-2mm rearward from the back edge of the tail rotor transmission housing #0421. This should result in approximately 20mm distance between the tail rotor blades when folded together. Check both left and right tail rotor commands at low and high throttle positions for no binds. Adjust transmitter ATV's if necessary.

Step 6. **Gyro.**

A. Carefully read the gyro instructions provided. Set gyro sensitivity to approximately 40-50%. Turn gyro and radio switches on and check for proper gyro/rudder direction operation. Helicopter nose pulled to the left should result in a right tail rotor command. Reverse gyro if incorrect. When using a gyro, a battery pack with 1000mah minimum is recommended. When switching gyro on and off, observe that rudder servo retains its same centering position. If needed, adjust gyro centering per gyro instructions.

Step 7. **Elevator and Aileron Dual Rates and ATV's.**

The elevator servo ATV's should be set +/- 40 degrees servo travel. Depending on the characteristics of which you desire dual rates should be set for your flying style. A starting point of about 70% on aileron and elevator work well. ATV's should be set for no binding.

## XV. FINAL ASSEMBLY AND BALANCE

Parts and Equipment Required:

1 Helicopter Muffler or Tuned Pipe with Mounting Hardware

A. Install the Muffler or Tuned Pipe per its instructions. Connect a section of fuel line from the Tank clunk fitting to the carburetor, incorporating a fuel filter (not supplied) is recommended. Add a (muffler to tank line), with filter, if tank pressurization is desired.

B. Balance: Check the completed helicopter by suspending it from the flybar (with the flybar crosswise) just above a level surface. With an empty fuel tank, it should remain level or tilt forward no more than 6 or 7mm (1/4") as measured over the length of a skid. Adjust battery pack position (or similar system element) to achieve this.

## XVI. FINAL ASSEMBLY INSPECTION

A. Recheck entire machine for any loose nuts, bolts, or screws.

B. Re-check plans for proper installation.

C. Inspect radio installation. Check to see that there is no mistake in the operational direction of each servo with no binds.

D. Check all rod connections for proper installation.

E. Check all moving components on helicopter for bind free operation.

F. After completion of the final inspection, we recommend that you familiarize yourself with all stick movements, switches and functions of the radio system as it relates to your helicopter. Practice until you feel comfortably ready for your first flight. Be careful to always ensure that the batteries in your radio system are fully charged before each flying session. We recommend the use of a good battery voltage meter to monitor the voltage level during use.

## XVII. NECESSARY FLIGHT ITEMS

A. Obtain items necessary for flight use
1) Glow fuel(Nitro; about 10 - 30%)
2) Fuel pump (electric or manual)
3) Electric starter (12v)
4) Special starter extension (Part #4681 from Miniature Aircraft, USA)
5) 12v battery (preferably a gel-cell; 5.5 amp minimum)
6) 12 volt charger
7) 1.5v glow plug battery with charger
8) Extra glow plugs
9) Ample tools for field use
10) Frequency flag displaying your transmitters' frequency colors or numbers (Supplied with your radio system)
11) Power Panel (optional)

B. At the Flying Field:
1) Obey any flying field rules
2) Check the frequency board or any fliers for frequencies in use before turning on your transmitter
3) Perform a pre-first flight radio range check as per radio specifications
4) Pre-check all radio functions
5) Check for possible help from other helicopter pilots
6) Be sure not to leave radio unit on between usage

## XVIII. STARTING AND STOPPING OF THE ENGINE

**TO START:** Always start the engine by using the transmitter trigger only (high throttle trim, low throttle stick). Check idle-ups and throttle hold for proper position of switches (off). Connect the glow plug battery connection selected to the engine glow plug. Connect the starter to the 12v battery and check that it operates in a counter-clockwise rotation. Hold the rotor head firmly with one hand. Engage the starter extension on the starter with the starter cone on top of the engine start shaft and rotate. When the engine starts remove the starter and glow plug battery.

**TO STOP:** Set the transmitter throttle stick and trimmer to its lowest setting. If it does not stop, but is running slow enough to halt the rotor blades, then do so and remove the fuel line to stall the engine. In this case, re-adjust throttle ATV until engine may be stopped by use of a transmitter trimmer. (After daily use of your model, we recommend the use of an after run oil for engine protection.)

## XIX. FIRST FLIGHT ADJUSTMENTS

NOTE: After the first flight remember to check the static tracking.

A. Before flying double check direction of each control; tailrotor compensation direction and gyro direction. The first few flights should be limited to hovering only.

B. **Engine Carburetor Settings:** With the engine running, set the idle adjustments to enable the engine to maintain a rich reliable idle (trying to four cycle) at low throttle, mid to high trim. Set the high speed needle to accelerate, but slightly rich. The motor should transition smoothly from high rpm's to low rpm's during the flight of the helicopter. Short duration vertical climbs to test the top end are the safest method to get the high speed needle valve setting close.

**Throttle and Pitch Curve:** After the needle valves are adjusted the model can be trimmed for hover. The throttle curve should be adjusted so that the model is almost to the hover head speed just above quarter stick. This helps the model lift off smoothly and also allows you to do slow vertical descents without the engine dropping out. The throttle curve above half stick should also be adjusted so that slow vertical ascents can be made without the engine speeding up or slowing down. Simultaneously adjust the hover pitch and hover throttle for the head speed you want to hover at, also ensure that the model is hovering at half stick. Next adjust the high and low side of the normal pitch curve until the model has the collective response you want in a hoover.

NOTE: Try to maintain original hovering recommended pitch settings. Flight trim for fine tuning once engine settings have been achieved. Fine tune low pitch settings for acrobatic maneuvers desired. Fine tune high pitch settings to match performance level of engine used.

C. Tail Rotor Trimming: Adjust tail rotor trimming as needed by moving transmitter until a stabilized tail is achieved. Re-center trimmer and adjust tail rotor control rod clevises until tail stabilizes with trimmer in neutral.

D. Tail Rotor Compensation: With the model in a trimmed stationary hover adjust the top tailrotor compensation so that the nose of the model stays straight. Starting at a height of fifteen to twenty feet, descend and watch for the nose of model to change direction or drift to one side or the other. Adjust lower tail comps to correct this. NOTE: The speed that you ascend and descend should be as slow as a FAI pilot might ascend and descend his heli while performing a top hat maneuver.

E. Swashplate Trimming: When the helicopter drifts to the left or the right, adjust aileron transmitter trimmer until stabilized. Re-center trimmer and adjust lower swashplate aileron rods until stabilized again. Repeat same process for fore and aft (elevator) control.

Gyro:

F. If you are using a dual rate gyro adjust the high rate for hovering as high as it will go without oscillation of the tail once you get the model flying in forward flight. Adjust the gyro on the low rate as high as it will go without the tailrotor oscillating.

G. Main Rotor Blade Tracking: The tracking of the main rotor blades may be checked just prior to lift-off. Be sure to maintain a safe distance from your machine. The adjustments can be made by changing the length of the Hiller Rods, #0335, on each side of the head. A piece of colored tape must be applied to one blade during balancing in order to determine which blade is high or low. Tracking procedure:
- Blade speed is low, lower the higher blade
- Blade speed is high, raise the higher blade
- If blades are out an inch or better, re-check original bench pitch settings

H. Top Pitch: Adjust the top end pitch on your idle up functions so that the model will fly at full throttle without losing head speed. A model with to much top end pitch tends to be "pitchy" and unstable.

***We wish you good luck and many happy hours of flying!***
***If you have any further questions, feel free to call us.***

*The staff at Miniature Aircraft USA would like to express their appreciation to Tim Schoonard and Paul Bittengle for their time and dedication in the creation and final production of the X-Cell Graphite .60 SE Instruction Manual.*

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